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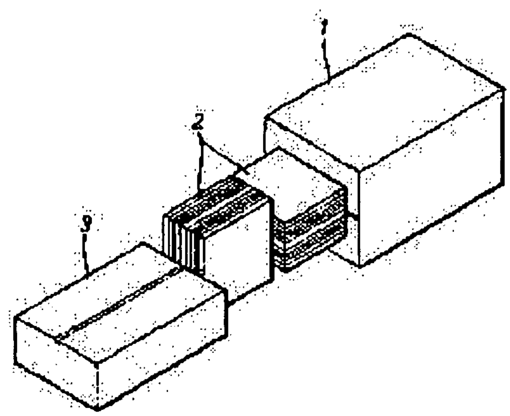
(54) OPTICAL COUPLING ELEMENT AND WAVELENGTH CONVERTER

(57)Abstract:

PURPOSE: To obtain short-wavelength coherent light of high output by making efficient wavelength conversion of a semiconductor laser beam by a nonlinear optical element.



CONSTITUTION: Optical coupling elements 2 which are the laminates formed by alternately laminating high-refractive index layers and low-refractive index layers are so constituted that the high-refractive index layers are thicker than the low-refractive index layers in the central part, that the former is gradually thinner and the latter is conversely thicker the furtherer from the center and that the relation between both is exactly opposite from the relation in the central part. These optical coupling elements 2 are adjacently disposed in such a manner that the laminated surfaces thereof intersect orthogonally with each other. The laser beam emission surfaces of the optical coupling elements 2 are tightly coupled to each other in such a manner that the active layers of a semiconductor laser parallels with the central high-refractive index layer of the optical coupling elements 2. The waveguide type nonlinear optical element 3 is tightly coupled to the high-refractive index layer in the central part of the optical coupling element 2 on the side opposite therefrom. The disposition is so adjusted that the laser beam is efficiently made incident on the waveguide of the nonlinear optical element. As a result, the output light of the semiconductor laser is efficiently guided to the waveguide nonlinear optical element from the semiconductor laser and, therefore, the higher harmonic coherent light of the high output and short wavelength is obtd.

LEGAL STATUS

[Date of request for examination]

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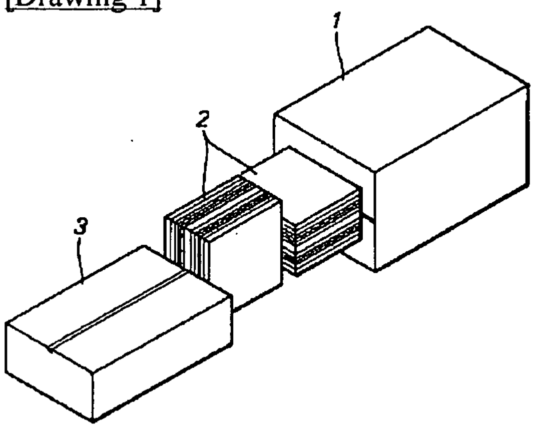
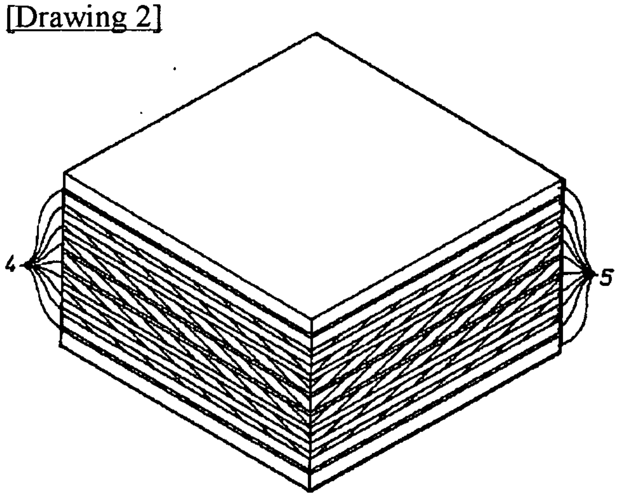
DRAWINGS

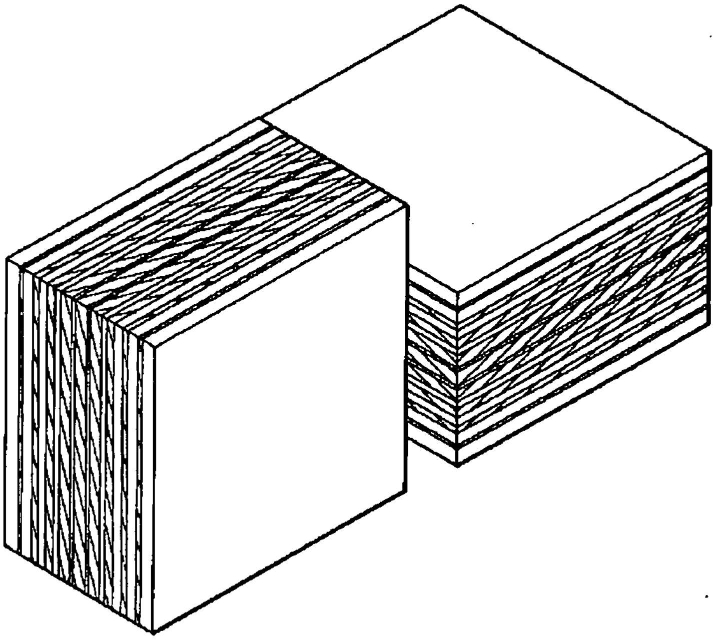
[Drawing 1]



[Drawing 2]



[Drawing 3]



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DETAILED DESCRIPTION

[Detailed Description of the Invention]
[0001]
[Industrial Application] Using a semiconductor laser component (LD component), a waveguide mold nonlinear optical element, and the optical coupling element for combining LD component and a waveguide mold nonlinear optical element, this invention carries out wavelength conversion of the basic laser beam efficiently, and relates to the wavelength converter for obtaining coherent short wave Nagamitsu of high power.
[0002]
[Description of the Prior Art] If LD light of the short wavelength of a blue - green field is called for as the light sources, such as optical disk memory, from the former, for example, a nonlinear optical element is made into waveguide mold structure, since a laser beam can be shut up in high density in waveguide, By being efficient, and it being known that second-harmonic light will be generated, and carrying out wavelength conversion of the LD light of long wavelength by Cherenkov radiation, false phase matching, etc. using such a waveguide mold nonlinear optical element The attempt which generates the second-harmonic light which is the short-wavelength-laser light of a blue - green field is performed briskly. Here, since the radiation angle is large, in order to carry out the light guide of this to a waveguide mold nonlinear optical element, the outgoing radiation light from LD component condenses by the optical coupling element for combining LD component and a waveguide mold nonlinear optical element, and needs to extract. As such an optical coupling element, lens system optical coupling elements, such as a single lens, were usually used.
[0003] On the other hand, LD component and a waveguide mold nonlinear optical element are produced by the epitaxial method, and, as for the barrier layer of LD component, and the light guide section of a waveguide mold nonlinear optical element, the magnitude of the cross section serves as a micron unit. Therefore, lens system optical coupling elements, such as a single lens, were not adjusted in [LD component or a waveguide mold nonlinear optical element] size, but in the optical coupling element using such a lens system optical coupling element, the joint loss at the time of a light guide was not avoided, but optical coupling effectiveness became about 30%, and the coupling scheme with more high effectiveness was called for.
[0004]
[Problem(s) to be Solved by the Invention] In view of the trouble of this conventional technique, the main purposes of this invention are efficient, combine LD light with a waveguide mold nonlinear optical element, and are to offer the wavelength converter for obtaining the 2nd higher-harmonic light of high power.
[0005]
[Means for Solving the Problem] According to this invention, the purpose mentioned above A semiconductor laser component and a waveguide mold nonlinear optical element, In the wavelength converter which consists of an optical coupling element for combining said semiconductor laser component and said waveguide mold nonlinear optical element The laminating of the layer which said optical coupling element becomes from the medium of a high refractive index, and the layer which consists of a medium of a low refractive index is carried out by turns. The ratio of the thickness of the layer which consists of an adjoining medium of a low refractive index to the thickness of the layer which consists of said medium of a high refractive index So that it may have the 1st and 2nd laminating devices which are min at an optical-axis core, and increase as it separates from said optical-axis core and the laminating side of said 1st laminating device may become parallel to the barrier layer of said semiconductor laser component It is attained by offering the wavelength converter characterized by adjoining the outgoing radiation end face of said semiconductor

laser component, being arranged, adjoining the outgoing radiation end face of said 1st laminating device, and being arranged so that the laminating side of said 2nd laminating device may become perpendicular to said barrier layer.
[0006]
[Function] such structure, then LD component and a waveguide mold nonlinear optical element were produced -- epitaxial -- an approach similar to law -- it is -- the laminating device as an optical coupling element -- since it is producible in detailed structure -- size ---like -- adjustment -- it is easy. since [moreover, / which near an optical axis is high as for the effective refractive index of this optical coupling element, and keeps away from an optical axis] it is produced so that it is alike, and may follow and may become low -- a single lens -- the same -- LD light -- condensing -- and a focus can be carried out and improvement in optical coupling effectiveness can be expected.
[0007] Furthermore, an effective refractive index n is [0008], using A as a multiplier for r by using the distance from an optical axis, and n0 into the refractive index on an optical axis.
[Equation 1]

$$n = n_0 (1 - A r^2 / 2)$$

[0009] The laser beam passing through the inside of the optical coupling element to which the laminating of a high refractive-index layer and the low refractive-index layer was carried out so that it might become can draw the optical path of the letter of a sign, and can make light condense in the direction of one dimension like a cylindrical lens. Here, the greatest breadth of the light beam in a laminating device is very narrow, can be extracted and can put a great portion of light into a waveguide mold nonlinear optical element easily.
[0010] When it produces using two laminating devices which described the optical coupling element above, the 1st laminating device The outgoing radiation end face of LD component is approached, and it arranges so that a laminating side may become the barrier layer of LD component, and parallel. The 2nd laminating device The outgoing radiation end face of the 1st laminating device is approached, and it arranges so that it may become the 1st laminating side and perpendicular of a laminating device, so that a laminating side may become the barrier layer and perpendicular of LD component that is,. The outgoing radiation light-emission angle from LD component will be large in a direction perpendicular to a barrier layer, the laser beam which carried out outgoing radiation from the barrier layer end face of LD component since it was small in an parallel direction will be perpendicularly condensed by the 1st laminating device, and, subsequently it will condense with the 2nd laminating device in parallel. Here, since the difference of the effective refractive index of near the optical axis of a laminating device and the periphery separated from the optical axis is large, even if it makes it detailed structure, it can be condensed.
[0011] Thus, if the light guide of the LD light is carried out to a waveguide mold nonlinear optical element and wavelength conversion of the basic laser beam is carried out by false phase matching, second-harmonic light can be generated.
[0012]
[Example] Hereafter, the drawing of attachment of the suitable example of this invention is explained in detail.
[0013] Drawing 1 is drawing showing the structure of a wavelength converter where this invention was applied, and consists of an optical coupling element 2 which turns into the LD component 1 which carries out outgoing radiation of the basic laser beam from two laminating device 2a for condensing a basic laser beam, and 2b, and a waveguide mold nonlinear optical element 3.
[0014] The output wavelength of the laser light source LD component 1 is 860nm, and an output is 100mW. The outgoing radiation edge dimension of the barrier layer of the LD component 1 is 1x3 micrometers, and is a half wave quantity full value (FWHM) from here, and outgoing radiation is perpendicularly carried out in parallel by the 10-degree radiation angle 30 degrees to a barrier layer.
[0015] Laminating device 2a and 2b are produced by vacuum deposition, the laminating of the CaF two-layer is carried out to the ZnSe layer by turns as a low refractive-index layer component as a high refractive-index layer component, and a ZnSe layer is thin as it is the thickest in the center section which is based on opticals axis and approaches a periphery. On the contrary, CaF two-layer is thick as it is the thinnest near the center which is near an optical-axis core and approaches a periphery. If it sees as an effective refractive index, a center section has a high refractive index and the periphery has a low refractive index. Here, it is the effective-refractive-index distribution n. The laminating of a ZnSe layer and the CaF two-layer is carried out so that it may be set to n0=1.80 and A= 0.988. Both the dimensions of

laminating device 2a and 2b are 500x500x300 micrometers, and it considers being arranged at the point-blank range of LD component and a waveguide mold nonlinear optical element, and the plane of incidence and outgoing radiation side serve as a flat surface and parallel.
[0016] It is arranged so that an optical coupling element may consist of two laminating devices in this way, and 1st laminating device 2a may approach the outgoing radiation end face of LD component and a laminating side may become parallel to the barrier layer of LD component. 2nd laminating device 2b approaches 1st laminating device 2a, is arranged, and it is arranged so that the laminating side may become perpendicular to the barrier layer of the LD component 1. Such laminating device 2a and 2b have the same condensing function as a cylindrical lens respectively. The outgoing radiation light-emission angle from LD component is large in a direction perpendicular to a barrier layer, and small in an parallel direction. Then, it condenses perpendicularly by 1st laminating device 2a first, and, subsequently condenses in parallel with 2nd laminating device 2b. Here, since the difference of the effective refractive index of a center section and the periphery of each laminating device 2a and 2b is large, it can condense with a detailed device.
[0017] In addition, although CaF2 was used as ZnSe and a low refractive-index layer as a high refractive-index layer in this example, ZnS may be used as a high refractive-index layer, and MgF2 may be used as a low refractive-index layer.
[0018] In this way, by the optical coupling element, it condenses, and the focus of the LD light is carried out, and it carries out incidence to the waveguide mold nonlinear optical element 3. Second-harmonic light with an output of 10mW which the light guide effectiveness to a waveguide mold nonlinear optical element could realize the high value of 90% in the wavelength converter of this example according to this structure, and was changed into short wavelength by the waveguide mold nonlinear optical element by false phase matching was obtained. The waveguide mold nonlinear optical element of this example is a periodic domain reversal channel mold here, by using KTP as a substrate and permuting K+ by Rb+, a channel and a domain are produced and the period of a domain is [6x10 micrometers and the channel length of the magnitude of 4 micrometers and a channel cross section] 7mm.
[0019]
[Effect of the Invention] By the above explanation, according to the wavelength converter by this invention, the light guide of the basic laser beam from a semiconductor laser component can be efficiently carried out to a waveguide mold nonlinear optical element so that clearly, and the short-wavelength-laser light of the blue of high power - a green field can be offered.

[Translation done.]

CLAIMS

[Claim(s)]
[Claim 1] In the optical coupling element for combining a semiconductor laser component and a waveguide mold nonlinear optical element The laminating of the layer which consists of a medium of a high refractive index, and the layer which consists of a medium of a low refractive index is carried out by turns. The optical coupling element to which the ratio of the thickness of the layer which consists of an adjoining medium of a low refractive index to the thickness of the layer which consists of said medium of a high refractive index is min at an optical-axis core, and is characterized by having the laminating device which increases as it separates from said optical-axis core.
[Claim 2] The optical coupling element according to claim 1 characterized by having said two laminating devices which a mutual laminating cross section contacts so that a laminating side may intersect perpendicularly mutually.
[Claim 3] In the wavelength converter which consists of an optical coupling element for combining a semiconductor laser component, a waveguide mold nonlinear optical element, and said semiconductor laser component and said waveguide mold nonlinear optical element The laminating of the layer which said optical coupling element becomes from the medium of a high refractive index, and the layer which consists of a medium of a low refractive index is carried out by turns. The ratio of the thickness of the layer which consists of an adjoining medium of a low refractive index to the thickness of the layer which consists of said medium of a high refractive index So that it may have the 1st and 2nd laminating devices which are min at an optical-axis core, and increase as it separates from said optical-axis core and the laminating side of said 1st laminating device may become parallel to the barrier layer of said semiconductor laser component The wavelength converter characterized by adjoining the outgoing radiation end face of said semiconductor laser component, being arranged, adjoining the outgoing radiation end face of said 1st laminating device, and being arranged so that the laminating side of said 2nd laminating device may become perpendicular to said barrier layer.

[Translation done.]